THE BASIS FOR MODELLING THE FISCAL SHOCKS' IMPACT ON THE BUSINESS ENVIRONMENT OF SLOVAKIA

Peter Horvát, Brian König, Filip Ostrihoň

INTRODUCTION

In the presented paper a Japanese DSGE model will be adopted to capture the dynamics of business environment in the conditions of Slovakia.It is assumed that government sector has a significant influence on the condition of business environment in general. Among other the main factors that affect business sector are the legal framework, the government expenditures, the level and the structure of taxation and the interest rates. Besides the legal framework, which unfortunately cannot be modelled through chosen DSGE model, other mentioned factors are incorporated in the model, although in reality the interest rates for Slovakia are set outside the Slovak economy.Given previous reasons it would be appropriate to adjust the model to the Slovak conditions. Therefore the paper provides calibration of some frequently discussed parameters and estimation of other parameters through econometric methods according to the Slovak data.

1 LITERATURE REVIEW AND USED MODEL

In the following section several strands of literature, which deal with the issue of describing the fiscal policy through the Dynamic Stochastic General Equilibrium (DSGE) model framework will be reviewed. Described section also provides some insight into the model which has been selected as the most promising for the purpose of modelling the impact of the fiscal shocks on the business environment of Slovakia.

1.1 EXAMINATION OF FISCAL POLICY THROUGH DSGE FRAMEWORK

With the growth of popularity of DSGE models evermore economic phenomena are being modelled using such framework. Consequently the need for evaluation of the fiscal policy has been modelled through DSGE models as well. Issues such as common fiscal policy for European Union or the stimulus package used in the USA [7] formed a demand for usage of mentioned models in governmental decision making.

There already is variety of DSGE models tackling aforementioned issue, such as the model introduced by Ishiwa [3]. Mentioned work uses standard medium scale DSGE model, with an abundance of rigidities to determine the efficiency of fiscal policy in Japan. The model incorporates several fiscal policy rules, while assessing the postulate of non – Ricardian households, which have been commonly used for modelling the impacts of policy institutions. Since the existence of non – Ricardian households is less probable for the conditions of Japan economy, the paper focuses on the correct identification of fiscal policy rule and the feedback variables. Moreover, the paper is aimed at identification of optimal fiscal policy financing, since the fiscal expenditures has to be covered by additional taxation, which has opposite effect than the initial shock. The model has been estimated according to quarterly historical data for Japan. Among the other findings the paper states that the fiscal policy can be more effective if it is only lightly funded by the labour – dampening taxation.

Other notable example is the model proposed by Perendia and Tsoukis[7], who introduced a Taylor – like rule for the government spendingand a revision to the information about the lifetime resources of households into a standard New Keynesian model. Such fiscal rule should serve counter cyclical and should be more reasonable in addition to the monetary measures for the stabilisation of economy than a model with mere government spending exogenous variable. The authors subsequently estimated various versions of the model according to the historical data of the USA. By calculating the multiplicative effects of government spending for the US economy they found the multipliers to be more Keynesian than Neoclassical.

Taylor – like rule for fiscal policy is also the main tool embedded in model of Kliem and Kriwoluzky [4].Similarly to the previous approach the authors have introduced their own fiscal policy rule, which was inspired by the Taylor rule for the monetary policy, in a conventional New Keynesian model, which incorporates various rigidities, households and monetary authority. The rule is based on feedback variables which ascertain the automatic stabilizing effect on the economy. The authors have set the welfare optimizing policymaker as a choice for feedback variables, which havebeen subsequently selectedas investment and labour hours for capital and labour income taxation respectively. After estimation,according to the quarterly US data, the authors have found that the Taylor – like rule itself isn't optimal while the selected feedback variables are strongly supported.

1.2 CHOSEN MODEL FOR THE CONDITIONS OF SLOVAKIA AND A BRIEF DESCRIPTION

For the purposes of presented analysis the model described by Ishiwa [3] was chosen, since other relevant models focus on identification of Taylor – like rule, which is not the aim of our analysis. As was already stated in the section 1.1 chosen model relies on non – Ricardian households, whose share has been believed to be significant for the conditions of Slovakia [8]. A rigorous description of the model will not be given in this section, since the whole description is stated in the source literature [3]. Instead of that the section provides a rather brief overview of the model and stresses the key features.

The model itself is largely based on DSGE model of the euro area, introduced by Smets and Wouters [6], which incorporates several frictions and significant number of shocks. After the estimation for the euro area the model shows strong presence of the sticky prices for the euro area. Subsequently the extended version of their model has been further developed by Coenen and Straub [1] adding sticky wages to the sticky prices and the distinction between Ricardian and non – Ricardian households, which is significant for the modelling of Slovak economy. The estimation according to the aggregated euro area data showed that the share of non – Ricardian households is relatively small, but their presence is nevertheless important for better fit of the government expenditures shock.

Ishiwa [3] further augments Coenen's and Straub's[1] model by taxation on consumption, labour and capital income and corresponding fiscal policy feedback rules for government spending. Given that the used model can be summarised as following. The households are modelled as a sum of Ricardian (households maximizing their lifetime utility) and non – Ricardian (households consuming all of their current income). The Ricardian households act also as wage setters for all of the households, while the non – Ricardian households are slowly adjusting to the Ricardian. The firms, on the other hand, are divided between perfectly competitive final good firms (using bundler technology) and monopolistically competitive intermediate good firms (using an increasing returns to scaleCobb – Douglas technology), The price setting process uses same logic as the wage setting, where the intermediate good firms are the ones allowed re – optimization. The fiscal policy is modelled via state balance of income and expenditures in each given year incorporating the taxation on capital income, labour income and consumption, government expenditures and government bonds. Therefore the model had to be augmented with four additional fiscal policy rules. Ishiwa [3]introduced the rules for capital income, labour income and consumption taxation, where government debt is used as feedback variable for all of them. Additionally he introduced a government spending rule for which the feedback variable is the output gap. The monetary authority is modelled as simple feedback rule with the feedback variables of inflation and output gap. Subsequently the aggregated consumption is given as the weighted mean of Ricardian and non – Ricardian households, while the labour supply is the same for aggregated, Ricardian or non – Ricardian households. On the other hand the aggregated government bonds, investment, stock of capital and the dividends are modelled only as the share of Ricardian households, since these are the households that produce savings. For closing the model aggregate production rule is introduced.

The advantages of described model are that it allows for computation of fiscal multipliers and an assessment of various combinations of fiscal policy.

2 DATA AND METHODOLOGY

For the purposes of estimation of prior values of parametersthe data available at Slovak statistical office [10] were used.For the intended estimation of the model, particularly the time series of real government consumption, real gross domestic product (GDP), private consumption, investment, labour hour, wage, inflation rate, interest rate, aggregate effective tax rates on consumption and labour income will be used. All mentioned series were available quarterly, from 1993Q1 to 2012Q4 although there were variables available only for a much shorter range. Thus our sample consists out of 56 to 80 observations, depending on the used variables. All the time series were seasonally adjusted in Eviews through Census X12 and consequently transformed into logarithms of deviation from the steady state values using Hodrick – Prescot (HP) filter, set to the default settings for quarterly data ($\lambda = 1600$). Modelled logarithms of the deviations from the steady state values were represented bythe cyclical component obtained from the HP filter.

Described time series were used for Econometric estimation using nonlinear ordinary least square (OLS) method in order to obtain starting values for number of parameters. The database is also intended to serve for subsequent estimation of the complex DSGE model of Ishiwa [3] for the conditions of Slovakia via the methods of Bayesian inference.

3 CALIBRATION

In the following section the procedure of setting the prior values for parameters of the DSGE model will be described. In order to estimate the model as whole it is important to obtain the starting values or more precisely the prior distributions of the model's parameters. For accomplishing such goal the standard Econometric methods described in the previous section were used. Given methodology was used to estimate those parameters for which it seemed reasonable to use methods of Econometrics. However not all of the parameters may be obtained through the described procedure although for some parameter there actually exist a general consensus about their value for the conditions of Slovakia. Such parameters were calibrated based on references to other strands of literature, which dealt with similar or identical parameters for the conditions of Slovakia.

3.1 CALIBRATION BASED ON THE LITERATURE

In many cases the DSGE approach uses deep and structural parameters, which are sometimes impossible to estimate via the tools of regular Econometrics. In such scenarios the process of calibration may be applied. For ascertaining the validityof calibrated values of parameters relevant literature seems as a suitable tool either for choosingthe starting value of parametersor as a benchmark.

According to the Zeman and Senaj [8] the following parameters were calibrated. The degree of habit formation in consumption (h) has been set to 0.6, the inverse of the intertemporal elasticity of substitution (σ_c) has been set to 1.1 and the inverse of the work effort (σ_l) has been set to 2.5. Similarly the capital utility adjustment cost (ψ), Calvo prices parameter (ξ_w), Calvo wages parameter(ξ_p) and investment adjustment cost parameter (ζ) were calibrated according to the Zeman, Výškrabka and Senaj [9] to the values 0.25, 0.75, 0.75 and 4.953 respectively.

The parameters for indexation wages (γ_w), indexation prices (γ_p), share of non – Ricardian households (ω) and time discount factor (β) were also set following the work of Zeman and Senaj [8] to the values 0.6, 0.6, 0.5 and 0.99 respectively. Some parameters concerning the persistence of the shocks were calibrated according to the Zeman, Výškrabka and Senaj [9] and therefore the value of shock persistence parameters of shock to the preferences (ρ_b) and of investment adjustment cost shock (ρ_i) were set to 0.53 and 0.146 respectively. The persistence of the labor supply shock (ρ_l) was calibrated to the value 0.251 following the work of Němec [5]. The value of the last persistence shock parameter as well as the value of capital share parameterwas taken from the work of Horvát, König and Ostrihoň [2], setting values of parameters for persistence of productivity shock (ρ_α) and the capital share on productivity (α) to 0.95 and 0.56 respectively.

Unfortunately it was not possible to find a reference toalready used value for every parameter of the modelin the conditions of Slovakia. Therefore the parameters for the fixed cost of production (φ) and for the wage markup (λ_w)were left at the values used in the original model of Ishiwa [3], which were 1.45 and 0.5 respectively.

3.2 CALIBRATION BASED ON ECONOMETRIC INFERENCE

This section presentsresults of the estimation of the parameters, which were possible to estimateusing econometric methods. The first estimated equation is the autoregressive process of the government spending:

$$\hat{G}_t = \rho_g \hat{G}_{t-1} + (1-\rho_g)\phi_{gy}\hat{Y}_{t-1} + u_{tg} \quad (1)$$

where $\hat{G}_t$ is government expectation spending described as log-deviation of the steady state value, calculated in previous section, ρ_g government expectation autoregressive coefficient, ϕ_{gy} government expectation output gap coefficient, $\hat{Y}_{t-1}$ output gap and u_{tg} error term. The values of the estimated parameters are presented in the table 1.

Tab. 2: Estimated values of the parameters of the equation (1)

Parameter	Coefficient	Std. Error	t-Statistic	Prob.
ρ_g	0.471035	0.100638	4.680499	0.0000
$(1-\rho_g)\phi_{gy}$	-0.046989	0.160853	-0.292122	0.7710

Source: Authors calculation

From the estimation result it is possible to observe negative value of the term: $(1-\rho_g)\phi_{gy}$, which is

not in line with the expectation but based on the value of the t-statistic it is not possible to reject null hypothesis about statistical insignificance of the parameter. Only starting value of the parameter is needed, so estimation of the parameter$\phi_{gy} = -0.08883$ could be used despite the fact it is probably wrong. The parameters of the effective rates were estimated according to following equations:

$$\hat{\tau}_t^c = \rho_{tc}\hat{\tau}_{t-1}^c + (1-\rho_{tc})\phi_{tcb}(\hat{b}_{t-1} - \hat{Y}_{t-1}) + u_{tc} \quad (2)$$

$$\hat{\tau}_t^d = \rho_{td}\hat{\tau}_{t-1}^d + (1-\rho_{td})\phi_{tdb}(\hat{b}_{t-1} - \hat{Y}_{t-1}) + u_{td} \quad (3)$$

$$\hat{\tau}_t^k = \rho_{tk}\hat{\tau}_{t-1}^k + (1-\rho_{tk})\phi_{tkb}(\hat{b}_{t-1} - \hat{Y}_{t-1}) + u_{tk} \quad (4)$$

where $\hat{\tau}_t^c$ is average effective tax rate on consumption, ρ_{tc} consumption tax autoregressive coefficient, ϕ_{tcb} consumption debt tax coefficient, $\hat{b}_{t-1}$ expected debtdescribed as log-deviation of the steady state value, $\hat{\tau}_t^d$ average effective tax rate on labour, ρ_{td} labour tax autoregressive coefficient, ϕ_{tdb} labour debt tax coefficient, $\hat{\tau}_t^k$ average effective tax rate on capital, ρ_{tk} capital tax autoregressive coefficient and ϕ_{tkb} capital debt tax coefficient. The values of the estimated parameters of previous equations are presented in the table 2.

Tab. 2: Estimated values of the parameters of the equations (2-4)

Parameter	Coefficient	Std. Error	t-Statistic	Prob.
ρ_{tc}	0.229268	0.12708	1.804119	0.0768
$(1-\rho_{tc})\phi_{tcb}$	-0.09676	0.042558	-2.273616	0.027
ρ_{td}	0.3816	0.126669	3.012587	0.0039
$(1-\rho_{td})\phi_{tdb}$	0.000192	0.011549	0.016619	0.9868
ρ_{tk}	0.305743	0.129538	2.360251	0.0219
$(1-\rho_{tk})\phi_{tkb}$	0.019361	0.023173	0.835504	0.4071

Source: Authors calculation

The estimated values of the parameters $\phi_{tdb} = 0.00031$ and $\phi_{tkb} = 0.02789$ are, based on the values of the t-statistic, probably incorrect but as mentioned before they serve only as starting values. Same is valid for the value of the parameter $\phi_{tcb} = -0.125543$, which is statistically significant according to value of the t-statistic, but expected sign of the parameter is positive. The last estimated equation is monetary policy rule:

$$\hat{R}_t = \rho_r \hat{R}_{t-1} + (1-\rho_r)\phi_{r\pi}\hat{\pi}_{t-1} + (1-\rho_r)\phi_{ry}\hat{Y}_{t-1} + u_{tr} \quad (5)$$

where $\hat{R}_t$ is the expected value of the interest rates, ρ_r interest rates autoregressive coefficient, $\phi_{r\pi}$ interest rates inflation coefficient, $\hat{\pi}_{t-1}$ expected inflation and ϕ_{ry} interest rates output gap coefficient.

Tab. 3: Estimated values of the parameters of the equation (5)

Parameter	Coefficient	Std. Error	t-Statistic	Prob.
ρ_r	0.748697	0.06603	11.33876	0.0000
$(1-\rho_r)\phi_{r\pi}$	0.495004	0.617329	0.801848	0.4258
$(1-\rho_r)\phi_{ry}$	1.540336	0.431144	3.572671	0.0007

Source: Authors calculation

The estimated value of the autoregressive coefficient suggests considerable inertia of the interest rates. The value of the t-statistic of the estimated parameter $\phi_{r\pi} = 1.96975$ also indicates that the real value could be different, but value of the parameter $\phi_{ry} = 6.12874$ could be usable. In the table 4 is presented the comparison of the R^2 of the equations.

Tab. 4: Comparison of the R^2 and adjusted R^2 of the equations (1-5)

Equation	R^2	adjusted R^2
1	0.221541	0.211431
2	0.117704	0.101365
3	0.146101	0.130288
4	0.106137	0.089584
5	0.81924	0.813215

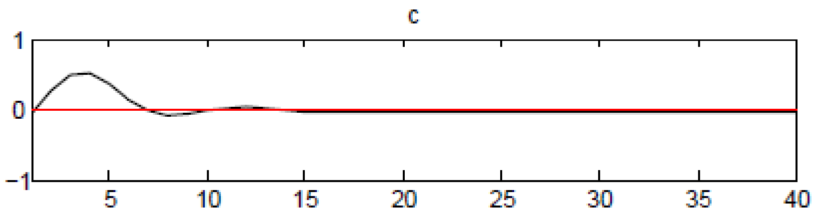
Source: Authors calculation

From the comparison it is possible to observe, based on the value of R^2, that only last equation provides solid statistical evidence for calibration of the parameters. However these values are needed only as a prior information as mentioned before and final posterior values could be different after Bayesian estimation.

3 PRILIMENARY RESULTS

Following section contains a preview of results based on the DSGE model of Ishiwa [3], which will be estimated for described calibration. These results are only preliminary and have been obtained through simulation of 5000 replications for thestarting values of the parameters. The parameters' values are expected to change after the Bayesian estimation, which will be computed in the next stage of the research. Therefore only the impulse response functions (IRF) for the final consumption are provided in the following preview.

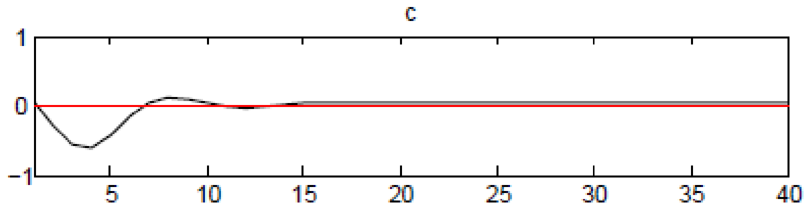
Fig. 2: Impulse response functionof final household consumption to government spending shock



Source: Authors'own calculation through DYNARE simulation.

The previous figure 1 depicts the IRF of final household consumption (FHC) which will react to 1 percentage positive shock to the government expenditures. As expected, the final household consumption rises immediately after the shock and it takes approximately 16 periods (4 years) for the consumption to return to the steady state.

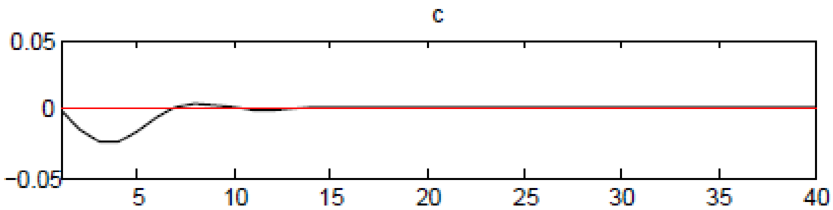
Fig. 3: Impulse response function of final household consumption to interest rate shock



Source: Authors' own calculation through DYNARE simulation.

Similarly the previous figure 2 shows the IRF of FHC responding to unexpected 1 percentage positive shock in interest rate. The immediate reaction to the shock is that the households will cut their consumption and will produce more savings. According to the figure 2 the shock will persist for less than 4 years.

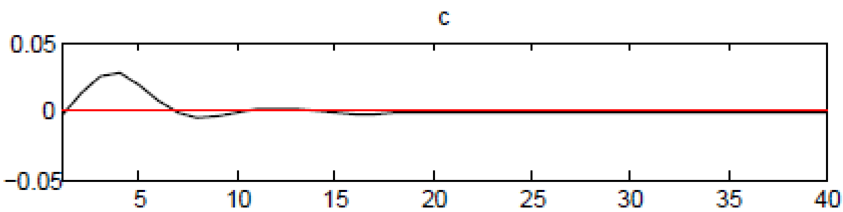
Fig. 4: Impulse response function of final household consumption to consumption tax shock



Source: Authors' own calculation through DYNARE simulation.

On the other side the 1 percentage shock in consumption taxation (figure 3) will lead toimmediate response of the FHC of significantly lower magnitude than the previous shocks. Also the shock will became almost untraceable after 3 years.

Fig. 5: Impulse response function of final household consumption to capital tax shock



Source: Authors' own calculation through DYNARE simulation.

Similarly the magnitude is lower for the immediate response of FHC to 1 percentage positive capital taxation shock. But the shock will persist longer than before mentioned shock stil the shock is expected to last less than 5 years. Given preview of results is only preliminary and with change of the parameters during the Bayesian estimation procedure it is expected that the shape, magnitude and persistence of the variable response to the shock will change as well. Because of that it would be invalid to publish IRF's of other variables. Subsequently after the parameters are estimated the IRF's for wages, GDP, inflation, interest rate and consumption will be published, considering that the consumption isn't expected to change dramatically.

CONCLUSION

To summarize, the paper provides obtained calibration for Slovakia based either on available literature or estimated through econometric inference in accordance to historical data. Following this methodology the foundation for modelling the effects of fiscal shocks on the Slovak economy was introduced using DSGE approach. The calibration was subsequently used in the simulation, which resulted into figures of IRF's of the FHC, stated in the section 4. It is intended to use described calibration as prior information for the future Bayesian estimation of the whole model. The expectations are that the estimated model will be able to capture the influence of the fiscal shocks of Slovak government on the various key macroeconomic indicators of business environment, such as GDP, inflation, interest rate and wages. In comparison to the source Japanese model the calibration of the feedback rule for all effective taxation rates expects lower impact of the feedback variables in the case of Slovakia. Also the autoregressive parameters in the case of Slovakia are expected to smooth the development of the taxation much less than in the case of Japan.

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Abstract: Followingpaper deals with Japanese DSGE model used to capture the dynamics of business environment in the conditions of Slovakia.It is assumed that government sector has a significant influence on the condition of business environment in general. The main factors that affect business sector are legal framework, government expenditures, the level and structure of taxation and the interest rates. The paper is organized as follows: the first chapter contains the literature review of papers where DSGE modelhas been used to deal with the issue of fiscal policy. Furthermore, the model proposed to be applied to the Slovak economy is described in this section. Next chapter provides information of the data used for the estimation of parameters used as priors. The third part speaks about the calibration of frequently discussed parameters and estimation of selected parameters through econometric methods, according to the Slovak data. Obtained calibration was based either on available literature or estimated through econometric inference in accordance to historical data. Following this methodology the foundation for modelling the effect of fiscal shocks on the Slovak economy was introduced using DSGE approach in the last section. The calibration was subsequently used in the simulation, which resulted into figures of IRF's of the FHC. The expectations are that the future model will be able to capture the influence of the fiscal shocks of Slovak government on the various key macroeconomic indicators of business environment, such as GDP, inflation, interest rate and wages.

Key words: DSGE, fiscal policy, calibration, econometric estimation

JEL Classification: C22, C63, D58, E27, E62